ZooKeys 1224: 129–140 (2025)
DOI: 10.3897/zookeys.1224.141248

Research Article

Cirrhimuraena taiwanensis sp. nov., a new species of cirri-bearing eel (Anguilliformes, Ophichthidae) from Yilan, northeastern Taiwan

Yen-Ting Lin[1], Yu-Hsiang Lin[1], Yu-San Han[1]

1 *Institute of Fisheries Science, College of Life Science, National Taiwan University, Taipei, Taiwan*
Corresponding author: Yu-San Han (yshan@ntu.edu.tw)

Abstract

A new species of cirri-bearing eel, *Cirrhimuraena taiwanensis* **sp. nov.** (Anguilliformes, Ophichthidae), is described based on a specimen collected from the estuary of the Langyang River (Yilan County), northeastern Taiwan. The new species is distinct from all congeners, except *C. odishaensis* and *C. orientalis*, in possessing a single row of mandibular teeth. *Cirrhimuraena taiwanensis* **sp. nov.** differs from *C. odishaensis* in having significantly shorter pectoral fins and fewer vertebrae, and it is distinguished from *C. orientalis* by its larger head, notably more total vertebrae, and a dorsal fin that originates well behind the gill opening. In the neighbor-joining tree based on COI sequences, the new species forms a distinct monophyletic group; thus, it is clearly separable from congeners both morphologically and genetically. With this addition, there are now 13 species in the genus *Cirrhimuraena*.

Key words: Biodiversity, brackish water, COI analysis, Taiwanese fringe-lip eel, taxonomy

OPEN ACCESS

Academic editor: Yahui Zhao
Received: 7 November 2024
Accepted: 11 December 2024
Published: 24 January 2025

ZooBank: https://zoobank.org/60197A0C-E82B-486A-ACAE-A8698E6CCAAE

Citation: Lin Y-T, Lin Y-H, Han Y-S (2025) *Cirrhimuraena taiwanensis* sp. nov., a new species of cirri-bearing eel (Anguilliformes, Ophichthidae) from Yilan, northeastern Taiwan. ZooKeys 1224: 129–140. https://doi.org/10.3897/zookeys.1224.141248

Introduction

The family Ophichthidae, commonly known as snake eels, represents the most varied group within the order Anguilliformes, containing two subfamilies (Myrophinae and Ophichthinae), with 62 genera and 361 species recorded (Fricke et al. 2024). In Taiwan, there have been reported of 19 genera and 60 species of snake eels identified (Chiu et al. 2018).

The genus *Cirrhimuraena* Kaup, 1856 belongs to the subfamily Ophichthinae and is known as cirri-bearing eels. This genus is notable for its unique morphological traits, particularly the presence of cirri, which are small, fleshy projections located on the upper jaw (Mohapatra et al. 2021). Cirri-bearing eels typically inhabit sandy or muddy substrates in coastal and estuaries waters (Mohapatra et al. 2021; Mohanty et al. 2023). Currently, 12 valid species are known, including *Cirrhimuraena chinensis* (Kaup, 1856), *C. tapeinoptera* (Bleeker, 1863), *C. cheilopogon* (Bleeker, 1860), *C. calamus* (Günther, 1870), *C. playfairii* (Günther, 1870), *C. oliveri* (Seale, 1910), *C. paucidens* (Herre & Myers, 1931), *C. inhacae* (Smith, 1962), *C. orientalis* (Nguyen, 1993), *C. yuanding* (Tang & Zhang, 2003), *C. indica* (Mohapatra, Mohanty, Ray, Mishra & Seth, 2021), and *C. odishaensis* (Mohanty, Behera, Patro & Mohapatra, 2023). Of these 12 species, only one, *C. chinensis*, has been recorded in Taiwan, and research on this genus remains scarce (Ho et al. 2015).

We conducted a survey of freshwater glass eels (juveniles of *Anguilla* spp.) in the the Langyang River estuary in northeastern Taiwan (24.7162°N, 121.8352°E) twice a month since 2010. Notably, this survey has yielded both a new species of Ophichthidae (*Lamnostoma taiwanense* Chiu, Huang & Shao, 2018) and new records of *Anguilla borneensis* Popta, 1924 and *A. interioris* Whitley 1938 (Chiu et al. 2018; Lin and Han 2024). In December 2023, a single *Cirrhimuraena* specimen was collected. A morphological analysis and molecular evidence indicated that this specimen represents an undescribed species. Although only a single specimen was obtained, its distinct morphology and genetic characteristics underscore its importance in advancing our understanding of *Cirrhimuraena* species in Taiwan. Furthermore, the discovery of new species and fish records highlights the need for conservation efforts to protect fish biodiversity in the Langyang River, one of the most critical habitats for Anguilliformes in Taiwan (Han et al. 2016).

Materials and methods

Sample collection

The specimen was collected from the estuary of the Langyang River in Yilan County, Taiwan (24.7162°N, 121.8352°E) on December 22, 2023. The environmental conditions of the collection site at the time of collection were as follows: substrate sandy, water depth 1 m, salinity 7‰, and water temperature 18 °C. A single, undescribed specimen of *Cirrhimuraena* was captured using a fyke net. Once collection, the specimen was photographed and radiographed, measured, and subsequently preserved in 95% ethanol. The specimen was deceased at the time of collection, and no live animals were included in this study.

Measurement and comparisons

The morphometrics were measured with digital calipers with an accuracy of 0.1 mm, and the meristic analysis and counting of head pores followed the protocol used by McCosker et al. (1989). The identified specimen was deposited in the collection of Biodiversity Research Museum of the Academia Sinica of Taiwan (**ASIZP**) under registration code ASIZP0082637. The specimen was compared with records of all congeners documented from Taiwan, *Cirrhimuraena chinensis*, and nearby waters, including *C. yuanding* from Pingtan, China (Tang and Zhang 2003), and *C. playfairii* from Okinawa, Japan (Hibino et al. 2021).

Molecular analysis

The dorsal muscle was dissected for the total genomic DNA extraction using the EasyPure Genomic DNA Spin Kit (Bioman Scientific, Taiwan). A polymerase chain reaction (PCR) was carried out to amplify the partial segment of the cytochrome c oxidase subunit I (COI) by using the forward primer FishF1+2 (5'-TCR ACY AAY CAY AAA GAY ATY GGC AC-3') and the reverse primers FishR1 (5'-TAG ACT TCT GGG TGG CCA AAG AAT CA-3') and FishR2 (5'-ACT TCA GGG TGA CCG AAG AAT CAG AA-3') following the protocol adjusted from Chang et al. (2016). The final PCR product was sequenced using the primer FishF1+2 by Genomics Scientific, Taiwan.

The COI sequences were aligned and trimmed using BioEdit v. 7.7.1, resulting in partial sequences of 562 base pairs. Once aligned, the sequences were saved in FASTA format and imported into MEGA v. 11 (Tamura et al. 2021) for phylogenetic analysis. A neighbor-joining (NJ) tree was constructed using the Kimura 2-parameter (K2P) distance model, with 10,000 bootstrap replicates to assess the reliability of the branches. Among all congeners, only two valid species of *Cirrhimuraena*, *C. chinensis* and *C. indica*, were available in the NCBI GenBank. In total, 16 sequences were used to construct the NJ tree. In the ingroup, *C. chinensis* (GenBank numbers KY472820.1, KX215192.1, KX215193.1, KX215194.1, MK264639.1, MK264640.1, MK264641.1, GU674221.1, and GU674224.1), *C. indica* (GenBank number MT019886.1), and *C. taiwanensis* sp. nov. (GenBank number PQ558516.1) were included. In the outgroup, and following the study by Mohapatra et al. (2021) were *Ophichthus lithinus* Jordan & Richardson, 1908 (GenBank number KU94289.1), *O. zophochir* Jordan & Gilbert, 1882 (GenBank number GU440436.1), *O. olivaceus* McCosker & Bogorodsky, 2020 (GenBank number MN480448.1), and *Pisodonophis cancrivorus* Richardson, 1848 (GenBank number KU942788.1, and MK777102.1). The details of all COI sequences used are listed in Table 1.

Table 1. The detail of the sequences used in the phylogenetic analysis.

Species	NCBI Accession number	Source	Voucher Number	Sampling Locality
Cirrhimuraena taiwanensis sp. nov.	PQ524198.1	This study	ASIZP0082637	Yilan, Taiwan
Cirrhimuraena chinensis	KY472820.1	GenBank	PT011	China
Cirrhimuraena chinensis	KX215192.1	GenBank	JLJ050	China
Cirrhimuraena chinensis	KX215193.1	GenBank	JLJ051	China
Cirrhimuraena chinensis	KX215194.1	GenBank	JLJ052	China
Cirrhimuraena chinensis	MK264639.1	GenBank	PTD055	China
Cirrhimuraena chinensis	MK264640.1	GenBank	PT055	China
Cirrhimuraena chinensis	MK264641.1	GenBank	QZ053	China
Cirrhimuraena chinensis	GU674221.1	GenBank	BWA6863	Indonesia
Cirrhimuraena chinensis	GU674224.1	GenBank	BWA6862	Indonesia
Cirrhimuraena indica	MT019886.1	GenBank	EBRC/ZSI/11811	India
Ophichthus lithinus	KU942789.1	GenBank	ASIZP0801626	Taiwan
Ophichthus olivaceus	MN480448.1	GenBank	KAU17-80	Saudi Arabia
Ophichthus zophochir	GU440436.1	GenBank	MFC132	California, USA
Pisodonophis cancrivorus	MK777102.1	GenBank	DOS05154	Vietnam
Pisodonophis cancrivorus	KU942788.1	GenBank	ASIZP0800053	Taiwan

Results

Family Ophichthidae

Cirrhimuraena taiwanensis sp. nov.

https://zoobank.org/3214769E-E179-46DD-B800-CE12D2A318B0

Figs 1–4, Table 2

Material examined. *Holotype*: Taiwan • ASIZP0082637, 178.1 mm total length (TL); Yilan; 24.7162°N, 121.8352°E; 22 Dec. 2023; caught by fyke net, ca 1 m, Yu-San Han & Yen-Ting Lin leg.

Diagnosis. A new *Cirrhimuraena* species with the combination of following characteristics: pectoral fin very small, only 15.2% of head length (HL) (in congeners > 21% HL); HK 9.7% of TL dorsal fin originates 1½ pectoral-fin length behind gill opening; tooth pattern unique, with only a single row of mandibular teeth; cirri on upper jaw 11; vertebrae 150, vertebral formula 13-53-150.

Description. The morphometric and meristic measurements of the holotype are shown in Table 2. Body very elongate, cylindrical; body height is almost consistent from gill opening to anus, with depth at gill opening of 2.2% of TL and depth at anus of 2.3% of TL. Head moderate, with head length (HL) 9.7% of TL. Tail longer than trunk, 63.6% of TL. Anal fin low, situated right after anus, with pre-anal length 36.8% of TL. Dorsal fin also low, originating far behind gill opening and pectoral fin; pre-dorsal length 13.2% of TL. Pectoral fin very small, 15.2% of HL, 1.5% of TL; pectoral-fin base positioned at same vertical as gill opening; gill opening positioned on latero-ventral side, length 16.4% of HL.

Eye relatively large, positioned nearer to snout tip than rictus; eye diameter 8.9% of HL; interorbital space slightly wider; interorbital length 6.1% of HL. Anterior nostril tubular, positioned at snout tip, while posterior nostril lies slightly behind orbit. Snout long, pointed, 19.1% of HL. Upper jaw longer than lower jaw, 35.7% and 26.9% of HL, respectively.

Five small cirri on edge of upper jaw between anterior and posterior nostrils; 6 cirri behind posterior nostril. No cirri on lower jaw and tip of jaw in front of nostrils. Dentition pattern illustrated in Fig. 3. Teeth numerous, closely arranged in a band, and primarily small and pointed, with slightly larger teeth at ends. Vomerine teeth in 1–3 rows, extending to posterior of maxilla; 5 teeth form a small patch at prevomer. Maxillary teeth in 2–6 rows of small, conical teeth; mandibular teeth band in only a single row on both sides. Pre-dorsal vertebrae 13, pre-anal vertebrae 53, and total vertebral 150.

Head pores tiny and indistinct, with supraorbital pores 1 + 3, infraorbital pores 3 + 2, preoperculomandibular pores 7 + 4, and supra-temporal pores 1 (Fig. 4). Lateral line pores before pectoral fin/gill opening 12, before dorsal-fin origin 16, and before anus 48.

Dorsal surface of body grayish, with numerous tiny black spots; some melanophores concentrated at tip of snout. Ventral side whitish. Dorsal and anal fins translucent; pectoral fin whitish.

Distribution. Currently only known from the type locality, with sandy substrate.

Etymology. The specific epithet *taiwanensis* refers to the location of the type locality, which recently only known in Taiwan; it is used as an adjective.

Remarks. Compared to all 12 congeners, *C. taiwanensis* sp. nov. can be easily distinguished from 10 species, except *C. odishaensis* and *C. orientalis*, in having only a single row of mandibular teeth (Fig. 4). However, *C. taiwanensis* sp. nov. can be separated from these two species morphologically, with comparative details shown in Table 3. The new species differs from *C. odishaensis* in having a shorter pectoral fin, only 15.2% of HL (compared to 21.3–25.0% HL in *C. odishaensis*); fewer vertebrae, with 13 pre-dorsal, 53 pre-anal, and 150 total vertebrae (vs 10 pre-dorsal, 46–47 pre-anal, and 160–162 total vertebrae in *C. odishaensis*); and fewer rows of maxillary teeth (2–6 rows in *C. taiwanensis* sp. nov. vs 3–7 rows in *C. odishaensis*). Compared to *C. orientalis*, *C. taiwanensis* sp. nov. has a larger head at 9.7% of TL (vs 5.5–6.2% of TL in *C. orientalis*), significantly more vertebrae (150 vs 131–136 in *C. orientalis*),

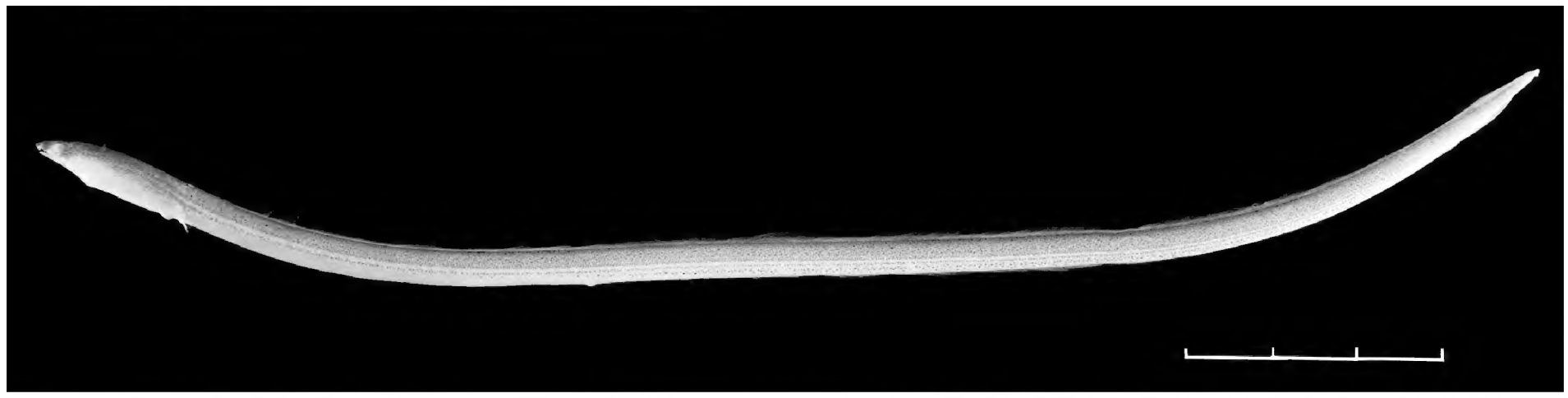

Figure 1. *Cirrhimuraena taiwanensis* sp. nov., ASIZP0082637, 178.1 mm total length. Scale bar: 30 mm.

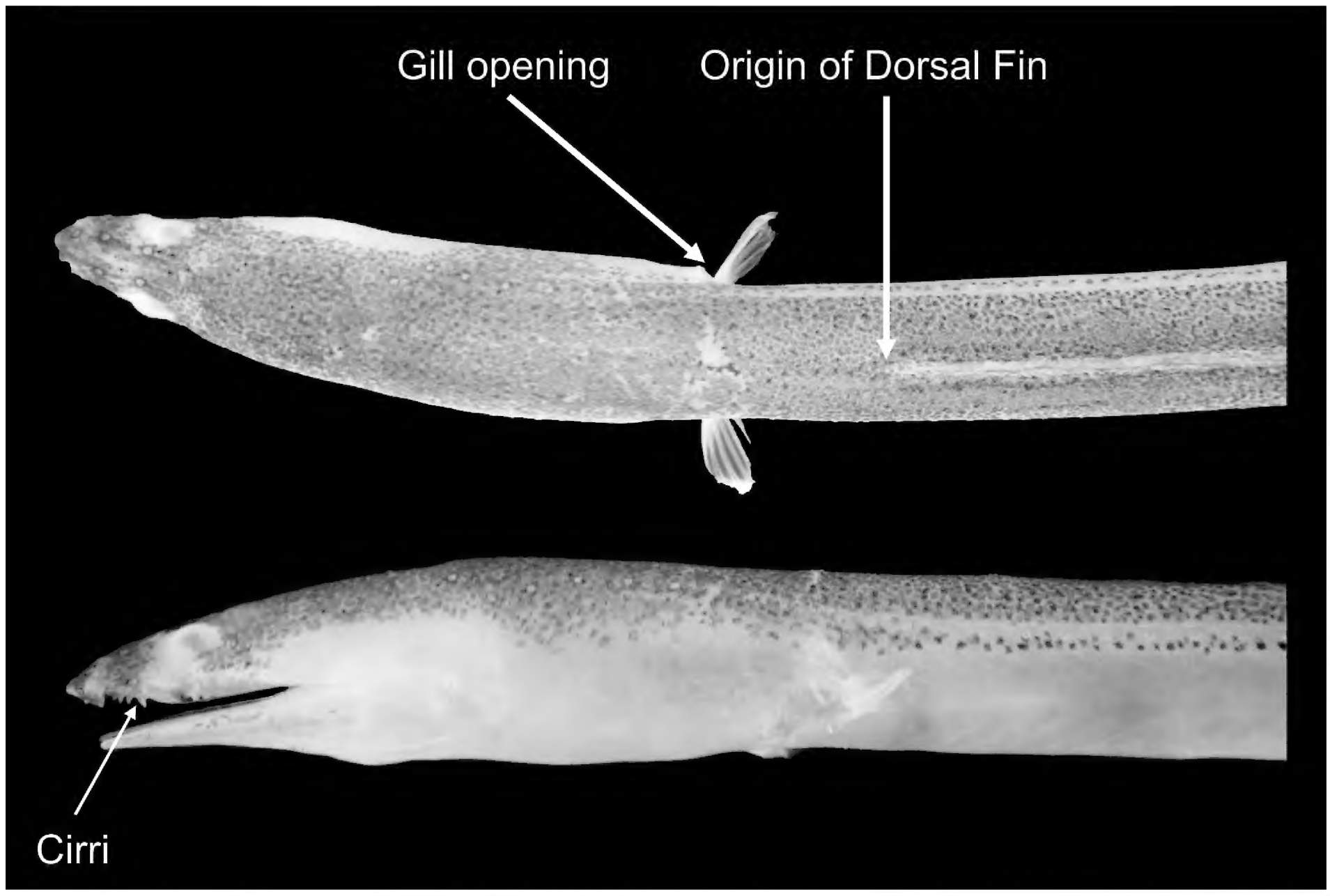

Figure 2. Head profile of *Cirrhimuraena taiwanensis* sp. nov. **A** origin of dorsal fin well behind gill opening **B** arrow indicates cirri on upper jaw.

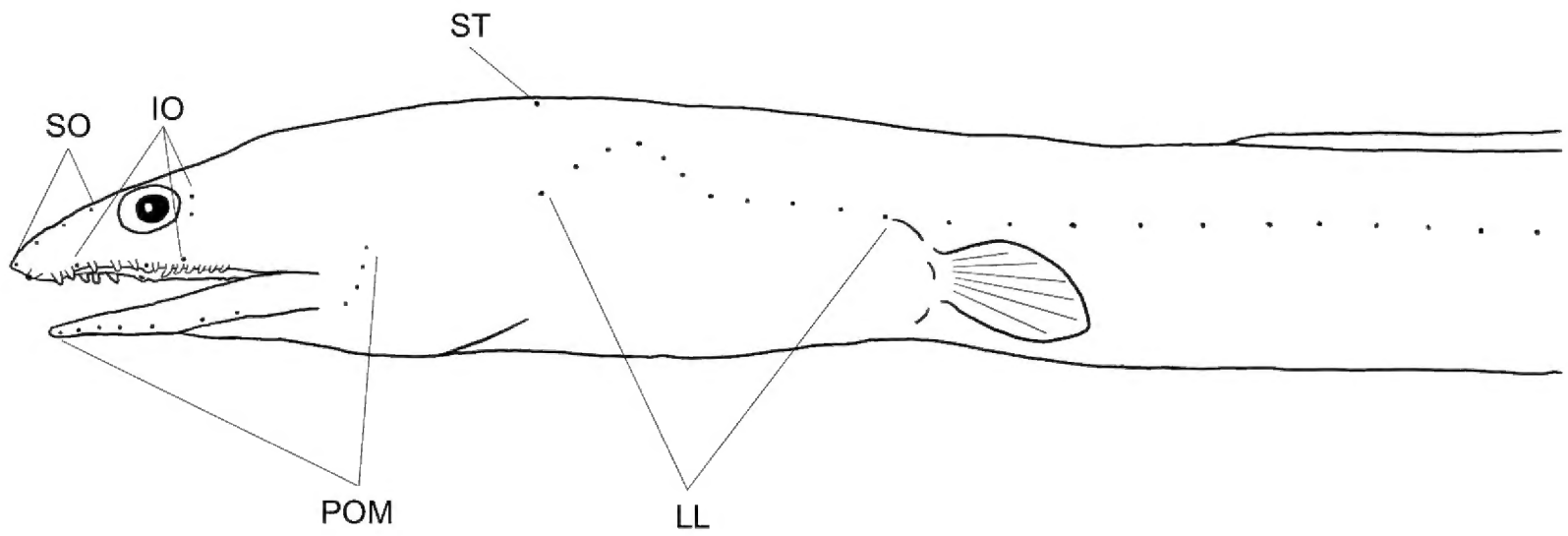

Figure 3. Head and lateral line pores in *Cirrhimuraena taiwanensis* sp. nov. Abbreviaitons: IO: infraorbital pores; LL: lateral-line pores; POM: preoperculomandibular pores; SO: supraorbital pores; ST: supra-temporal pores.

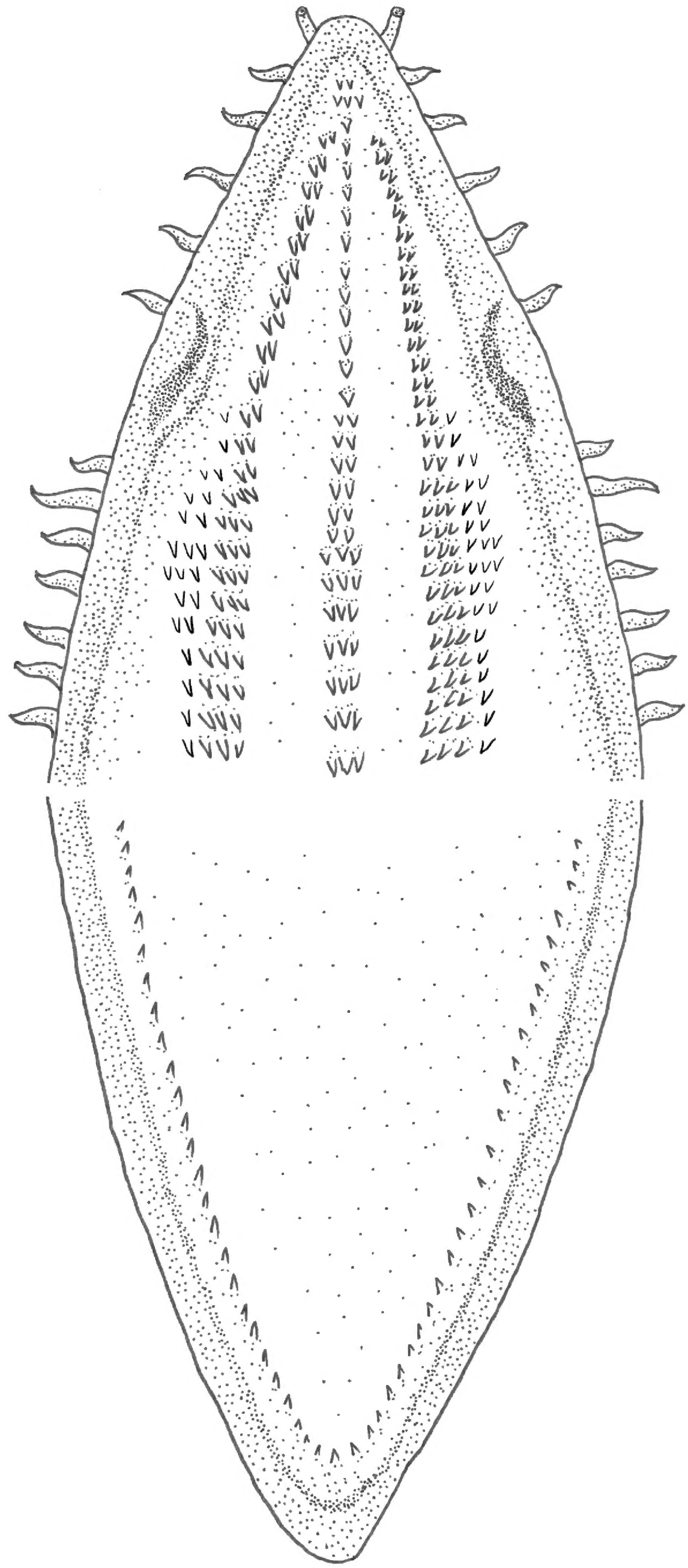

Figure 4. Tooth dentition pattern in upper and lower jaws of *Cirrhimuraena taiwanensis* sp. nov. (holotype, ASIZP0082637, 178.1 mm total length).

Table 2. Morphometric and meristic data of *Cirrhimuraena taiwanensis* sp. nov.

	Cirrhimuraena taiwanensis* sp. nov. Holotype, *ASIZP0082637
Total length (SL, mm)	178.1
Head length (HL, mm)	17.4
Pre-anal length (PAL, mm)	65.6
Pre-dorsal length (PDL, mm)	23.6
% in HL	
Snout length	19.1
Eye diameter	8.9
Interorbital length	6.1
Upper jaw length	35.7
Lower jaw length	26.9
Gill opening length	16.4
Pectoral-fin length	15.2
% in TL	
Head length	9.7
Pre-anal length	36.8
Pre-dorsal length	13.2
Trunk length	27.1
Tail length	63.6
Depth at gill opening	2.2
Depth at anus	2.3
Pores	
Supraorbital	1 + 3
Infraorbital	3 + 2
Preoperculomandibular	7 + 4
Pores before pectoral fin	11
Pores before dorsal fin	16
Pores before anus	48
Vertebrae	
Pre-dorsal	13
Pre-anal	53
Total	150

and more rows of maxillary teeth (2–6 rows in *C. taiwanensis* sp. nov. vs 2–3 rows in *C. orientalis*).

Molecular results. Sixteen COI sequences from three taxa were analyzed, revealing nine unique haplotypes across 562 aligned base pairs, which included 196 variable sites and 151 parsimony-informative sites. The NJ tree analysis identified *C. taiwanensis* sp. nov. in a well-supported clade (bootstrap values 99%) with all other *Cirrhimuraena* species included in NCBI (Fig. 5). The av-

Table 3. Morphometric comparisons of *Cirrhimuraena taiwanensis* sp. nov. with congeners with only a single row of mandibular teeth.

	***Cirrhimuraena taiwanensis* sp. nov. (This study)**	***C. odishaensis* (Mohanty et al., 2023)**	***C. orientalis* (Nguyen., 1993)**
HL % in TL	9.7	9.1–10.6	5.5–6.2
Pectoral fin % in HL	15.2	21.3–25.0	—
Mandibular teeth	1 row	1 row	1 row
Maxillary teeth	2–6 rows	3–7 rows	2–3 rows
Total vertebrate	150	160–162	131–136

— No data available.

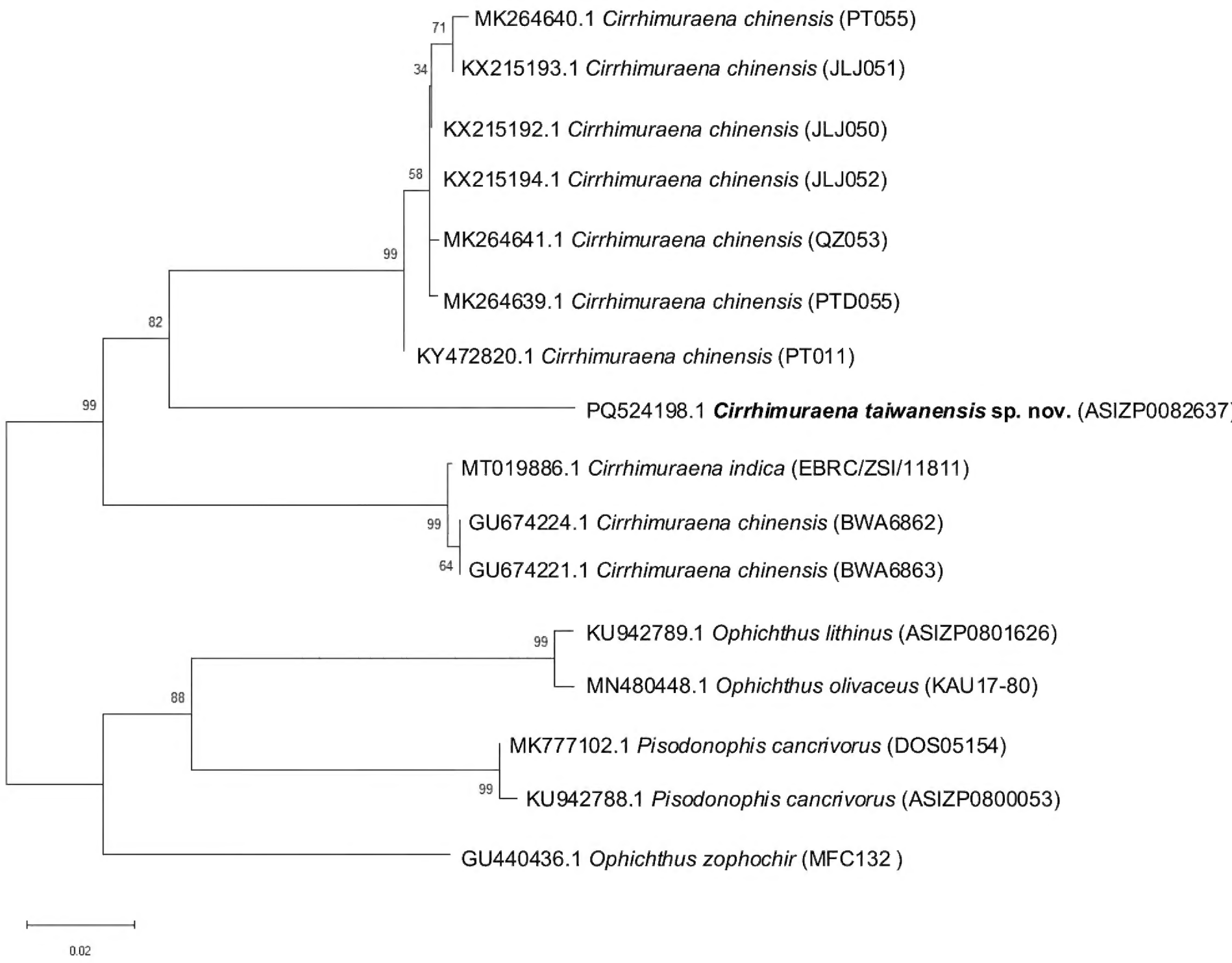

Figure 5. The neighbor-joining tree based on COI sequences of *Cirrhimuraena taiwanensis* sp. nov. and all the valid congeners in NCBI.

erage pairwise K2P genetic distance between *C. taiwanensis* sp. nov. and its congeners is 0.124, aligning with the average genetic distance typically found among congeneric fish species, as reported by Ward et al. (2005). Within the *Cirrhimuraena* group, *C. taiwanensis* sp. nov. and most *C. chinensis* specimens are clearly separated (bootstrap value 99%) from *C. indica* and two *C. chinensis* specimens collected in Indonesia (GU674221.1 and GU674224.1), which are suspected misidentifications of *C. indica* (Mohapatra et al. 2021). *Cirrhimuraena taiwanensis* sp. nov. also demonstrates a distinct separation from *C. chinensis*, with high bootstrap support of 82% and forming a unique monophyletic group. The distinct morphological characteristics and NJ tree results further support the separation of *C. taiwanensis* sp. nov. as a distinct species.

Discussion

Currently, there are 12 valid species in the genus *Cirrhimuraena*, and the distribution in the northwestern Pacific Ocean is primarily centered around the South China and Java Seas (Mohapatra et al. 2021; Mohanty et al. 2023). Only one species, *C. chinensis*, has been recorded from Taiwanese waters, from along the coast of Pingtung in southwestern Taiwan and Kinmen Island (Shao et al. 2008; Ho et al. 2015). Additional to *C. chinensis* recorded in Taiwanese waters, in the subtropical

North Pacific there are two additional species: *C. playfairii*, recorded from Makiya, Okinawa Island, Japan (Hibino et al. 2021: fig. 6b, c), and *C. yuanding*, recorded from Pingtan County, Fujian Province, China (Tang and Zhang 2003) (Fig. 6).

In Table 4, we compare the new species, which exhibits distinct morphological differences from congeners found in Taiwanese waters (*C. chinensis*) and nearby regions (*C. yuanding* and *C. playfairii*). The two species recorded from China (*C. yuanding*) and Japan (*C. playfairii*) can be clearly distinguished from *C. taiwanensis* sp. nov. by the position of the dorsal fin, which originates in front of the gill opening in both *C. playfairii* and *C. yuanding*, with a pre-dorsal length (PDL) shorter than the HL (Table 4). Compared to the *C. chinensis*, *C. taiwanensis* sp. nov. has a significantly shorter pectoral fin at 15.2% of HL (vs 45.2–51.6% HL in *C. chinensis*); a smaller gill opening length at 16.4% of HL (vs 25.4–30.1% HL in *C. chinensis*); dorsal fin that originates well behind the gill opening, with a PDL of 13.2% TL (vs 9.6–11.2% TL in *C. chinensis*); and a slightly smaller head, at 9.7% TL (vs 10.9–11.8% TL in *C. chinensis*) (Table 4). Furthermore, molecular data confirm the distinction between *C. chinensis* and *C. taiwanensis* sp. nov., with a high bootstrap value (82%) supporting their separation (Fig. 5).

There are also notable morphological differences between *Cirrhimuraena taiwanensis* sp. nov. and other Indo-West-Pacific congeners. *Cirrhimuraena calamus* and *C. oliveri* both have significantly smaller heads, measuring 16.6% pre-anal length (PAL) in *C. calamus* (Günther 1870) and 16.4% of PAL in *C. oliveri* (Seale 1910), compared to 26.5% PAL in *C. taiwanensis* sp. nov.; *C. tapeinoptera*, *C. cheilopogon*, and *C. inhacae* have significantly larger pectoral fins, approximately 40–50% HL

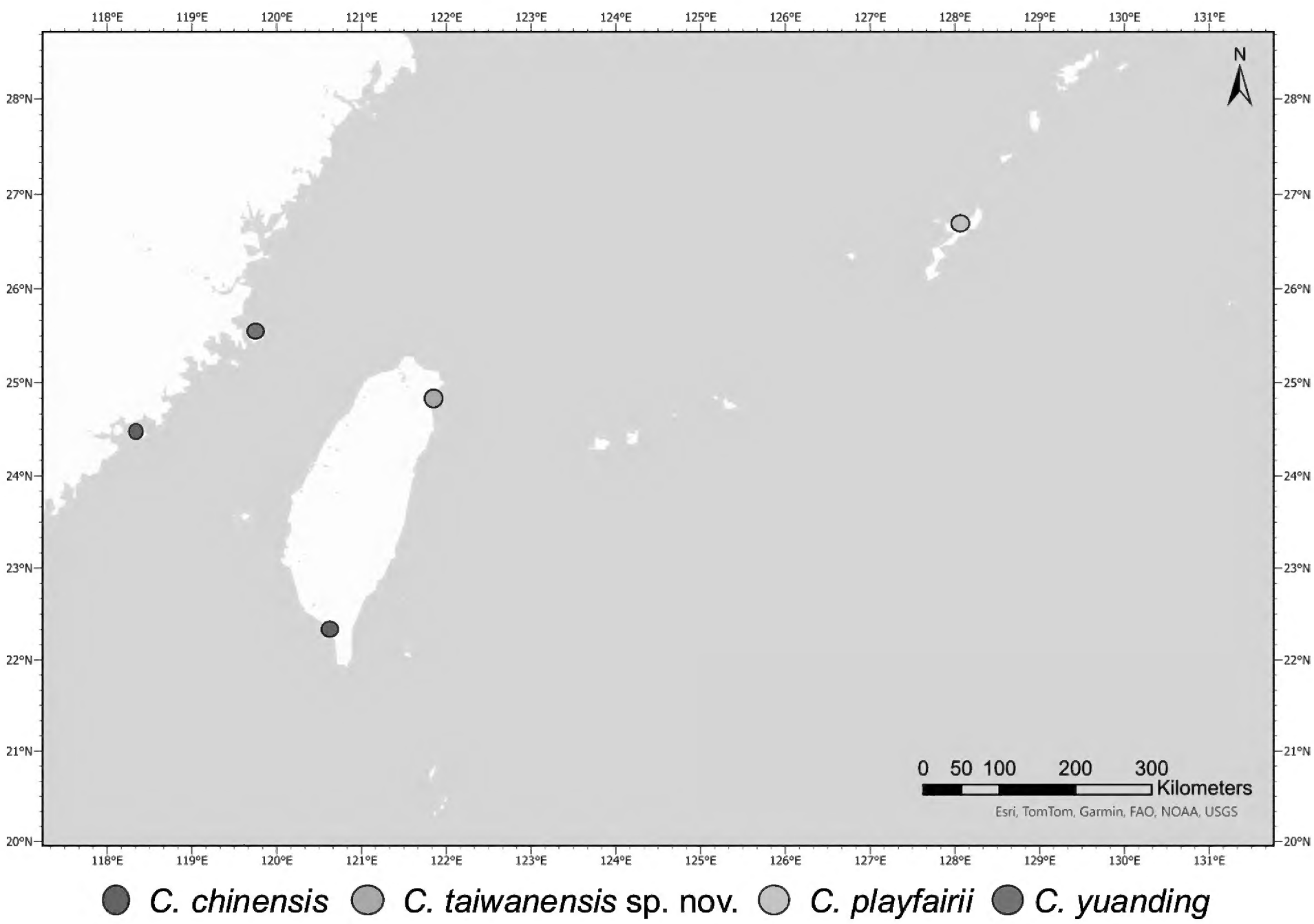

Figure 6. Distribution map of *Cirrhimuraena* species found in Taiwanese waters and nearby regions.

Table 4. Comparisons of *Cirrhimuraena taiwanensis* sp. nov. and *C. chinensis* in Taiwan, and two other congeners recorded from nearby waters.

	***Cirrhimuraena taiwanensis* sp. nov. Holotype**	***C. chinensis n = 10***	***C. yuanding n* = 1 (Tang and Zhang 2003)**	***C. playfairii n* = 1 (Hibino et al. 2021)**
Collection site	Taiwan	Taiwan	China	Japan (Okinawa)
Total length (SL, mm)	178.1	227–293	520.5	229
Head length (HL, mm)	17.4	23.5–28.9	30.0	—
Pre-anal length (PAL, mm)	65.6	89.3–94.2	161.3	—
Pre-dorsal length (PDL, mm)	23.6	25.5–28.2	20.5	—
% in HL				
Snout length	19.1	18.9–22.7	16.0	15.3
Upper jaw length	35.7	37.1–40.0	24.0	31.3
Lower jaw length	26.9	34.5–43.5	—	—
Gill opening length	16.4	25.4–30.1	12.7	8.6
Pectoral-fin length	15.2	45.2–51.6	28.3	23.3
% in TL				
Head length	9.7	10.9–11.8	5.8	7.1
Pre-anal length	36.8	32.1–39.4	31.0	33.6
Pre-dorsal length	13.2	9.6–11.2	3.9	4.6
Depth at gill opening	2.2	2.5–3.3	1.8	2.0
Depth at anus	2.3	2.8–3.7	2.2	2.1
Vertebrate				
Pre-dorsal	13	11	—	4
Pre-anal	53	49	—	60
Total	150	154	—	183

— No data available.

(Weber and de Beaufort 1916; Smith 1962; Smith and Heemstra 1986) vs 15.2% in *C. taiwanensis* sp. nov.; *C. taiwanensis* sp. nov. also has a shorter pre-anal length, at 36.8% TL, compared to 41.8% in *C. paucidens* (Catania and Fong 2020; Mohapatra et al. 2021). The combined morphological and molecular differences between the new species and all 12 congeners strongly support that the specimen we collected represents a distinct new species, *Cirrhimuraena taiwanensis* sp. nov.

The habitat of the *Cirrhimuraena taiwanensis* sp. nov. is at the estuary of the Langyang River, where the water is brackish year round and has an abundance plankton. The river estuary serves as an important habitat for the Anguilliformes and other brackish and freshwater fish species (Shih et al. 2008; Dahms et al. 2012; Han et al. 2016). The substrate is sandy, and the brackish-water environment is typical habitat for the *Cirrhimuraena* species (Mohanty et al. 2023). With the description of the new species, the ecological importance of the Langyang River estuary is enhanced; this estuary already serves as the type locality of *Lamnostoma taiwanensis* and habitat for other anguillid species in Taiwan (Chiu et al. 2018; Lin and Han 2024). In addition, the these new and recently described species suggests that many more unidentified species may be present in brackish waters, which highlight the importance of these environments for biodiversity.

Acknowledgements

We thank Zhen-Hui Chen (local fisherman) for assisting us in setting the fyke net and providing various sampling support, Chien-Hsiang Lin and Hsin-Wei Liu (Biodiversity Research Center, Academia Sinica) for photographing specimen and

offering curatorial insights for this research, and Hong-Ji Veterinary Hospital for helping taking the radiograph for the specimen. We sincerely thank the academic editor, Dr. Yahui Zhao, two anonymous reviewers, and Dr. Mohapatra for their invaluable comments and suggestions to improve the quality of this manuscript.

Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statement

No ethical statement was reported.

Funding

The authors extend our gratitude to the National Science and Technology Council, Executive Yuan, Taiwan (MOST 111-2313-B-002-016-MY3) for funding this project.

Author contributions

The sample collecting was performed by Yu-San Han and Yen-Ting Lin. Yen-Ting Lin conducted the measurement and write the manuscript; Yu-Hsiang Lin for the head profile and dentition drafting; Yu-San Han designed and supervised the experiments. All authors participated in manuscript writing and interpretation of results. All authors read and approved the final manuscript.

Data availability

All data that support the findings of this study are available in the main text, and the holotype is deposited in the collection of Biodiversity Research Museum of the Academia Sinica of Taiwan, under registration code ASIZP0082637.

References

Catania D, Fong J (2020) CAS Ichthyology (ICH). Version 150.227. California Academy of Sciences. https://doi.org/10.15468/efh2ib

Chang CH, Lin HY, Ren Q, Lin YS, Shao KT (2016) DNA barcode identification of fish products in Taiwan: government-commissioned authentication cases. Food Control 66: 38–43. https://doi.org/10.1016/j.foodcont.2016.01.034

Chiu YC, Shao KT, Huang SP, Chen HM (2018) The freshwater snake eel genus *Lamnostoma* (Anguilliformes: Ophichthidae) in Taiwan, with description of a new species. Zootaxa 4454(1): 18–32. https://doi.org/10.11646/zootaxa.4454.1.4

Dahms HU, Tseng LC, Hsiao SH, Chen QC, Kim BR, Hwang JS (2012) Biodiversity of planktonic copepods in the Lanyang River (northeastern Taiwan), a typical watershed of Oceania. Zoological Studies 51(2): 60–174.

Fricke R, Eschmeyer WN, Van der Laan R (2024) Eschmeyer's Catalog of Fishes: Genera, Species, References. [Accessed on 2024-5-11]

Günther A (1870) Catalogue of the Fishes in the British Museum. Vol. 8. Trustees of the British Museum, London, [xxv +] 549 pp.

Han YS, Wu CR, Iizuka Y (2016) Batch-like arrival waves of glass eels of *Anguilla japonica* in offshore waters of Taiwan. Zoological Studies 55: e36. https://doi.org/10.6620/ZS.2016.55-36

Hibino Y, Miyamoto K, Sakurai Y, Kimura S (2021) Annotated checklist of marine eels (Actinopterygii: Anguilliformes) stranded by a serious cold wave in January 2016 in Ryukyu Islands, Japan, including two newly recorded species of Japan. Bulletin of the Kitakyushu Museum of Natural History, Series A 19: 13–26. https://doi.org/10.34522/kmnh.19.0_13

Ho HC, Smith DG, McCosker JE, Hibino Y, Loh KH, Tighe KA, Shao KT (2015) Annotated checklist of eels (orders Anguilliformes and Saccopharyngiformes) from Taiwan. Zootaxa 4060(1): 140–189. https://doi.org/10.11646/zootaxa.4060.1.16

Lin YT, Han YS (2024) Species diversity of freshwater glass eel (Anguilliformes, Anguillidae) of Yilan, Taiwan, with remark on two new records. In: Ho HC, Russell B, Hibino Y, Lee MY (Eds) Biodiversity and taxonomy of fishes in Taiwan and adjacent waters. ZooKeys 1220: 5–14. https://doi.org/10.3897/zookeys.1220.125590

McCosker JE, Böhlke EB, Böhlke JE (1989) Family Ophichthidae. In: Böhlke EB (Ed.) Fishes of the Western North Atlantic, Number 1 Part 9. Sears Foundation for Marine Research, Yale University, New Haven, Connecticut, 254–412.

Mohanty SR, Behera RK, Patro S, Mohapatra A (2023) A new species of cirri-bearing eel of the genus *Cirrhimuraena* (Anguilliformes: Ophichthidae) from the coastal Bay of Bengal, India. Zootaxa 5315(6): 575–583. https://doi.org/10.11646/zootaxa.5315.6.5

Mohapatra A, Mohanty SR, Ray D, Mishra SS, Seth JK (2021) A new species of the genus *Cirrhimuraena* (Anguilliformes: Ophichthidae) from the Bay of Bengal, India. Journal of Fish Biology 98(5): 1363–1370. https://doi.org/10.1111/jfb.14671

Nguyen KH (1993) Cá biên Viêt nam [Marine Fishes of Vietnam]. Vol. 2. Part 2. (Anguillomorpha, Cyprinomorpha, Atherinomorpha). Science & Technology Publishers, Hanoi and Ho Chi Minh City, 176 pp. [In Vietnamese]

Seale A (1910) New species of Philippine fishes. The Philippine Journal of Science. Section A, General Science 4(6): 491–543.

Shao KT, Ho HC, Lin PL, Lee PF, Lee MY, Tsai CY, Liao YC, Lin, YC (2008) A checklist of the fishes of southern Taiwan, northern South China Sea. Raffles Bulletin of Zoology Supplement 19: 233–271.

Shih SS, Lee HY, Chen CC (2008) Model-based evaluations of spur dikes for fish habitat improvement: A case study of endemic species *Varicorhinus barbatulus* (Cyprinidae) and *Hemimyzon formosanum* (Homalopteridae) in Lanyang River, Taiwan. Ecological engineering 34(2): 127–136. https://doi.org/10.1016/j.ecoleng.2008.07.016

Smith JLB (1962) Sand-dwelling eels of the western Indian Ocean and the Red Sea. Ichthyological Bulletin 24: 447–466.

Smith MM, Heemstra PC (1986) Smiths' Sea Fishes. Macmillan South Africa, Johannesburg, 1047 pp. https://doi.org/10.1007/978-3-642-82858-4

Tamura K, Stecher G, Kumar S (2021) MEGA 11: Molecular Evolutionary Genetics Analysis version 11. Molecular Biology and Evolution 38(7): 3022–3027. https://doi.org/10.1093/molbev/msab120

Tang WQ, Zhang CG (2003) A new species of the genus *Cirrhimuraena* from the East China Sea (Pisces, Anguilliformes, Ophichthidae). Acta Zootaxonomica Sinica 28(3): 551–553.

Ward RD, Zemlak TS, Innes BH, Last PR, Hebert PD (2005) DNA barcoding Australia's fish species. Philosophical Transactions of the Royal Society B: Biological Sciences 360(1462): 1847–1857. https://doi.org/10.1098/rstb.2005.1716

Weber M, de Beaufort LF (1916) The Fishes of the Indo-Australian Archipelago. Vol. 3. E.J. Brill, Leiden, 455 pp. https://doi.org/10.1163/9789004590434